S

ENGINEERING CHANGE NOTICE

1. ECN 661800

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental ○ Direct Revision ◉ Change ECN ○ Temporary ○ Standby ○ Supersedure ○ Cancel/Void ○	J. Young, Nuclear Safety & Licensing, K7-97, 375-4510	○ Yes ◉ No	08/08/00
	6. Project Title/No./Work Order No.: RPP	7. Bldg./Sys./Fac. No.: RPP	8. Approval Designator: N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.): RPP-5453, Rev. 0	10. Related ECN No(s).: N/A	11. Related PO No.: N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Completed	12d. Restored to Original Condition (Temp. or Standby ECNs only)
○ Yes (fill out Blk. 12b) ◉ No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change — 13b. Design Baseline Document? ○ Yes ◉ No

Updated CAM availability analysis to support revised surveillance times in LCO 3.1.4.

14a. Justification (mark one)	14b. Justification Details
Criteria Change ◉ Design Improvement ○ Environmental ○ Facility Deactivation ○ As-Found ○ Facilitate Const ○ Const. Error/Omission ○ Design Error/Omission ○	Response to directed Change 5.2.2.a in the Safety Evaluation Report for the Implementation of an Alternating Control Strategy for LCO 3.1.4 Authorization Basis Amendment Package, ORP Letter 00-SHD-057, R. T. French to M. P. DeLozier, dated June 15, 2000.

15. Distribution (include name, MSIN, and no. of copies)

RELEASE STAMP

AUG 09 2000

DATE

STA: 4

ID:

4

A-7900-013-2 (10/97)

A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 661800

16. Design Verification Required	17. Cost Impact — ENGINEERING	17. Cost Impact — CONSTRUCTION	18. Schedule Impact (days)
○ Yes	Additional ○ $ N/A	Additional ○ $ N/A	Improvement ○ N/A
◉ No	*Savings* ○ $ N/A	*Savings* ○ $ N/A	Delay ○ N/A

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
Operating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
Conceptual Design Report	☐	*Installation Procedure*	☐	*Component Index*	☐
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
Const. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
Environmental Impact Statement	☐	*Fac. Proc. Samp. Schedule*	☐	*Tickler File*	☐
Environmental Report	☐	Inspection Plan	☐	________	☐
Environmental Permit	☐	Inventory Adjustment Request	☐	________	☐

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	*Document Number/Revision*	*Document Number/Revision*
None		

Approvals

	Signature	Date
Design Authority		
Cog. Eng.	FOR G. W. Ryan R4-47 [signature]	8 Aug '00
Cog. Mgr.	R. J. Cash R1-44 W. L. Cowley for [signature]	8 Aug '00
QA		
Safety		
Environ.		
Other	Licensing Eng. J. Young K7-97 [signature]	8 Aug '00
	Analys. Eng. G.D. Johnson, R1-44 W. L. Cowley for [signature]	8 Aug '00

	Signature	Date
Design Agent		
PE		
QA		
Safety		
Design		
Environ.		
Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

DISTRIBUTION SHEET

To	From	
Distribution	J. Young	Page 1 of 1
Project Title/Work Order		Date August 02, 2000
RPP-5453, Availability Analysis of the Ventilation Stack CAM Interlock System		EDT No.
		ECN No. 661800

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
R. J. Cash	R1-44	X			
J. M. Grigsby	R1-44	X			
E. C. Heubach	R1-43	X			
E. O. Thorne	R1-56	X			
J. Young	R1-44	X			
C. J. Williams	R1-44	X			

Availability Analysis of the Ventilation Stack CAM Interlock System

J. Young
CH2M HILL Hanford Group, Inc.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 661800 UC: 2030
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Key Words: *Authorization Basis, AB, Availability, Continuous Air Monitor Surveillance, System*

Abstract: Ventilation Stack Continuous Air Monitor (CAM) Interlock System failure modes, failure frequencies, and system availability have been evaluated for the RPP. The evaluation concludes that CAM availability is as high as assumed in the safety analysis and that the current routine system surveillance is adequate to maintain this availability credited in the safety analysis, nor is such an arrangement predicted to significantly improve system availability.

8/9/00

Release Approval Date

Release Stamp

Approved For Public Release

RPP-5453 REV 1

Availability Analysis of the Ventilation Stack CAM Interlock System

J. M. Grigsby
G&P Consulting, Inc.

E. O. Thorne
Tekton Resources, Inc.

J. Young
Pacific Northwest National Laboratory

Date Published
August 2000

Prepared for the U.S. Department of Energy

CH2MHILL
Hanford Group, Inc.

Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC06-99RL14047

RECORD OF REVISION	(1) Document Number RPP-5453	Page 1 of 1

(2) Title

Availability Analysis of the Ventilation Stack CAM Interlock System

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	Authorized for Release (6) Cog. Mgr. Date
0	(7) Original Issue (EDT# 628638)	G. L. Jones 01/04/00	R. J. Cash 01/04/00
RS 1	Issue entire document as Revision 1 via ECN 661800. Changes denoted by sidebar on pages 5, C-5, C-6, and E-1.	For G. W. Ryan [illegible] 8 Aug/00	R. J. Cash [illegible] 8/8/00

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CONTENTS

APPENDIXES

LIST OF TABLES

LIST OF TERMS

AB	authorization basis
CAM	continuous air monitor
FSAR	Final Safety Analysis Report
HEPA	High Efficiency Particulate Air (filter)
MTBF	mean time between failures
MTTR	mean time to repair
RAM	reliability, availability, and maintainability
RPP	River Protection Project
TSR	Technical Safety Requirement

1.0 SUMMARY

1.1 PURPOSE

The purpose of this report is to perform an availability analysis of the River Protection Project (RPP) Ventilation Stack Continuous Air Monitor (CAM) Interlock System to support development of responses to Contractor Surveillance Report Response Number: S99-TOD-TF-042-F01 (included in Appendix D) items 2 and 3.

- Item 2: Perform an engineering evaluation to determine failure modes that affect the intended safety function of the CAMs with regard to the interlock TSR and make necessary recommendations to correct any deficiencies.
- Item 3: Analyze surveillance frequency to determine adequacy.

The analysis computes CAM availability based on current RPP surveillance and maintenance practice, with a 30 minute alarm of all CAM failures, and assuming the TSR surveillance is the only CAM surveillance conducted.

1.2 CONCLUSION

Ventilation Stack Continuous Air Monitor Interlock System failure modes, failure frequencies and system availability have been evaluated for the RPP. The evaluation concludes that CAM availability is as high as assumed in the safety analysis and that the current routine system surveillance is adequate to maintain this availability. Further, requiring an alarm to actuate upon CAM failure is not necessary to maintain the availability credited in the safety analysis, nor is such an arrangement predicted to significantly improve system availability. However, if CAM failures were only detected by the 92-day functional tests required in the Authorization Basis (AB), CAM availability would be much less than that credited in the safety analysis. Therefore it is recommended that the current surveillance practice of daily simple system checks, 30-day source checks and 92-day functional tests be continued in order to maintain CAM availability.

2.0 BACKGROUND

The safety function of the CAM Interlock System is to shutdown active exhaust ventilation on a high radiation reading to limit the release of airborne radionuclides after HEPA filters are damaged by an in-tank spray leak or HEPA failure due to a high temperature accident. The HEPA Filter Failure – Exposure to High Temperature accident analysis (Tank Waste Remediation System Final Safety Analysis Report [FSAR] Section 3.3.2.4.2) assumes that the interlock shuts down the ventilation flow within 10 minutes of detecting the high radiation condition. No explicit CAM Interlock System availability is stated in the safety analysis, however the assumed availability can be inferred from the analysis in FSAR Section 3.4.3.1.1, Failure of Controls for HEPA Filter Failure – Exposure to High Temperature or Pressure. This analysis states that frequency of the initiating event (HEPA failure due to high temperature) is "anticipated" ($>10^{-2}$/yr to $\leq 10^{0}$/yr), while the frequency of the accident with failed controls (CAM Interlocks) is "unlikely" ($>10^{-4}$/yr $\leq 10^{-2}$/yr). This is nominally a factor of 100 reduction in the frequency, implying that the CAM Interlock system has a 99% probability of being available to mitigate this accident. The safety analysis assumption for CAM Interlock system availability is thus 0.99.

The question raised in Surveillance Number: S99-TOD-TF-042-F01 is, "can the CAM Interlock System meet its operability requirements if CAM Interlock System failures are not alarmed at a continuously manned (e.g., a control room manned 24 hours a day) location?" The CAM failure mode evaluation and surveillance frequency analysis question is clarified for this analysis to be, "Given the CAM Interlock System failure history, is it necessary to alarm CAM Interlock System failures at a continuously manned location in order to maintain the system availability credited in the safety analysis?"

This question is addressed by evaluating CAM Interlock System failure modes and failure rates over the past two years with system availability analysis and comparing the system availability to that credited in the safety analysis.

3.0 ANALYSIS

3.1 ANALYSIS APPROACH

The current RPP AB identifies the Continuous Air Monitor Interlock Systems as safety controls. The assessment of the effectiveness of the CAMs was based on the qualitative estimate that the CAMs reduced the accident frequency by about two orders of magnitude. This implies that the CAMs have an availability of 0.99. Availability is the probability that a system is in an operable condition at any random point in time.

An analysis was done to determine how accurate the qualitative assessment was and to identify what surveillance is required to achieve a CAM availability of 0.99. The analysis was based on two years of experience at RPP and the application of standard computational methods currently in use in system reliability, availability, and maintainability (RAM) analysis and for Probabilistic Risk Assessments (NUREG/CR-2300).

Availability can be computed by the following equation, where failures are discovered as a result of a surveillance activity (NUREG/CR-2300):

$$A = 1 - 1/2\lambda t \qquad (1)$$

where:

A: system/equipment availability

λ: system/equipment failure rate (failures/hour) t: surveillance interval (hours)

Alternatively, if there is relatively instantaneous failure detection, availability can be represented by (NUREG/CR-2300):

$$A = MTBF/(MTBF + MTTR) \quad (2)$$

where:

MTBF: system/equipment mean time between failure ($1/\lambda$)
MTTR: system/equipment mean time to repair (repair time includes failure detection and correction times)

Based on current RPP practice, equation (1) and equation (2) were both used to assess the current availability of the CAMs, and to determine if availability is driven more by the surveillance frequency or by the time needed to repair the system. CAM failure history was used to derive CAM failure rates. Because the CAMs are currently subject to three different types of surveillance actions, the CAM system was addressed as consisting of three subsystems, each made up of those components whose failure could be detected by a particular surveillance activity.

1. Equipment whose failures are detectable by the 24-hour simple system check surveillance;

2. Additional equipment whose failures are detectable by the 30-day source check surveillance; and

3. The remaining equipment whose failures are detectable by the 3-month Technical Safety Requirements (TSR) functional test surveillance.

Based on defining the CAM Interlock System as made up of three elements, the availability of the CAMs is computed as follows:

$$A_{CAM} = (A_1)(A_2)(A_3) \quad (3)$$

In practice, a number of different system checks are performed such as 6-hour operations checks, 24-hour Health Physics Technician checks, 15-day filter changes, etc. Some failures are alarmed. For the purposes of this availability analysis, alarmed failures and failures found during routine 6-hour operations checks are assumed to only be detected by the 24-hour (daily) simple system checks. Failures actually detected during 15-day filter changes are assumed to only be detected by the 30-day source checks.

Because the data available often does not include the exact time that the failure occurred, it has been assumed that failures occur, on average, in the middle of the surveillance interval. Sensitivity studies were performed to examine the impact of various proposed surveillance alternatives on CAM availability based on current failure experience. The cases examined were

(1) current practices, (2) reliance on the 92-day TSR functional test only, and (3) if CAM failures could be automatically alarmed and thus be instantaneously detected. In the last case, it was assumed that the alarm would detect failures for all surveillance activities listed previously. This assumption that the alarm could detect all of the failures detected by all hour surveillance activity is probably optimistic.

3.2 CAM FAILURE DATA ANALYSIS

Operational data from October 1997 through September 1999 were gathered and evaluated for 40 CAM Systems in operation at RPP whose failures are tracked in the occurrence reporting system. This operating experience comprises over 700,800 CAM hours of operation. System failures experienced over this time period are detailed in Appendix A. The failure modes and the surveillance that detected the failure have been evaluated. The results from the evaluation of operating experience are summarized in Table 1. The mean time between failures (MTBF) for the CAM System is 8,870 hours while the observed availability is 0.995 (99.5%). This is based on excluding exhauster down time when CAMs are not required. Based on this calculation, the observed availability is greater than the availability assumed in the safety analysis.

Table 1. RPP CAM System Failures.

	Found by Daily System Check	Found by Source Check	Found by Functional Test	Total
Number of failures	70	9	0	79
Failure frequency (λ)	9.99E-5/hr	1.28E-5/hr	1.43E-6[c]	1.1E-4/hr
MTBF (1/λ)	10,000 hrs	78,000 hrs	-	8,870 hrs
MTTR[a]	11 hrs	295 hrs	-	43.5 hrs
Availability	-	-	-	**0.995**[b]

[a] Excludes the time when exhauster was shutdown (thus CAM was not required to be available).
[b] Fraction of the past two years that the CAMs have been available based on operating data.
[c] Conservatively assumes one failure.

3.3 AVAILABILITY ANALYSIS RESULTS

The availability analysis equations described above have been applied to the CAM operating data to study how system availability may be affected by changes in surveillance practices. The calculations for the specific cases analyzed are included in Appendix B, including inputs and outputs for each case. The results are summarized in Table 2.

As shown in Table 2, availability analysis predicts that the current practice of performing a daily simple system check, a 30-day source check, and a 92-day system functional test results in an availability of 0.993. This compares well with the observed availability of 0.995 shown in Table 1. Further, having CAM Interlock System failures alarm at a continuously manned location is not necessary to maintain availability greater than 0.99. Such an arrangement is not predicted to significantly improve system availability because the system availability is driven more by repair time than detection time. Finally, it is noted that most CAM failures are detected by the daily simple checks while no reported failures have been detected by the TSR functional tests. Relying only on the 92-day TSR surveillance is predicted to reduce system availability to 0.876.

Revising the CAM surveillance to extend the daily check to 48 hours (plus 25%) and the monthly to 31 days (plus 25%) still provides 0.99 availability as shown in Cases 4 and 5.

Table 2. Results of CAM Interlock System Availability Analysis.

Case	Simple System Check Frequency (hrs)	Source Check Frequency (days)	System Functional Test Frequency (days)	Calculated CAMS Availability
Case 1 – Current Practice	24	30	92	0.993
Case 2 – Immediate Response Based on Alarmed Failures	0.5*	0.5*	0.5*	0.995
Case 3 – TSR Surveillance Only	None	None	92 (TSR)	0.876
Case 4 – Revised TSR Specified Surveillance	48	31	92	0.991
Case 5 – Revised TSR plus 25%	60	38	92	0.990

*0.5 hours is based on an alarm on CAM failure to a continuously manned location that detects all CAM failures.

4.0 REFERENCES

Contractor Surveillance Report Response, "Technical Safety Requirements," Number S99-TOD-TF-042-FO1, B. J. Harp, U.S. Department of Energy, Richland Operation Office (DOE-RL), September 2, 1999.

FSAR, 1999, *Tank Waste Remediation System Final Safety Analysis Report*, HNF-SD-WM-SAR-067, Revision 1, Lockheed Martin Hanford Company, Richland, Washington.

NUREG/CR-2300, 1983, *PRA (Probabilistic Risk Assessments) Procedures Guide: A Guide to the Performance of Probabilistic Risk Assessments for Nuclear Power Plants*, American Nuclear Society, LaGrange Park, Illinois.

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APPENDIX A

SUMMARY: HOURS OF SERVICE AND FREQUENCY OF CONTINUOUS AIR MONITOR FAILURES

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SUMMARY: HOURS OF SERVICE AND FREQUENCY OF CONTINUOUS AIR MONITOR FAILURES (see Table A-1)

1. Time Unavailable begins with the time the incident was discovered, and ends with the completion of repairs, or shutdown of the fan.
2. Hours Unavailable is the Time Unavailable plus one half the surveillance interval when the actual failure time is unknown.
3. There are 40 Beta-Gamma Continuous Air Monitor locations used in this evaluation.
4. The evaluation starts with Occurrence Reports from October of 1997 and ends with reports from September 1999.
5. In cases where the date of repair is known, but the time is not available, the assumed completion time is taken as 30 minutes before the end of the next shift or midnight of that day.
6. Discovery Period indicates the method and periodicity of failure discovery.

Total CAM hours, 10/97 through 9/99: 700800

Occurrence Reports: 58
CAM incidents: 87 (including 8 incidents not involving a CAM failure)
CAM hours unavailable: 3438

Means of failure discovery:

Ops (6 hr)	31
HPT (24 hr)	14
Craft (0 hr)	6
Cont Rm Ops (0 hr)	15
Testing (0 hr)	4
Source Chk (720 hr)	5
Filter Chg (336 hr)	4

Discovery Totals		Hours Unavailable	Hours / Incident
≤24 hrs	70	782 hrs	11
≤720 >24hrs	9	2656 hrs	295
>720 hrs	0	0	0

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
1	204-AR Primary Stack	RL-PHMC-TANKFARM-1998-0015	Personnel LCO 3.1.4A	Fuse/fuse holder broken by scaffold use	2/12@1:08 - 12hrs 2/12@1:29	12:21	HPT 24
	204-AR Primary Stack	RL-PHMC-TANKFARM-1998-0078	Equipment failure LCO 3.1.4A	Power supply breaker failed 2E-98-1412	7/7@8:25 - 3hrs 7/7@8:30	3:05	Ops 6
2	241-AN Primary Stack	RL-LMHC-TANKFARM-1999-0001	Equipment failure LCO 3.1.4	Vacuum pump power supply failed	10/1@8:36 - 3hrs 10/1@9:15	3:39	Ops 6
	241-AN Primary Stack	RL-PHMC-TANKFARM-1999-0048	Design anomoly LCO 3.2.1	Fan shutdown due to monitoring system breaker trip. AN-105,6 CAM's disconnected as precaution	7/26@10:08 7/26@10:55	00:47	Craft 0
3	241-AN-101 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
4	241-AN-102 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0138	Equipment failure LCO 3.2.6	Vacuum pump failed 2E-99-213	11/10@20:26 - 3hrs 11/10@24:00	6:34	Ops 6
5	241-AN-103 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
6	241-AN-104 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
7	241-AN-105 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
8	241-AN-106 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
9	241-AN-107 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0074	Equipment failure LCO 3.2.6	CAM failed source check 2E-98-1356 (Funct test performed Grave shift 7/1-7/2)	6/29@14:29 - 360hrs 7/2@7:30	425:01	Source Check 720
	241-AN-107 Annulus Leak Detection	RL-PHMC-TANKFARM-1997-0105	Equipment failure LCO 3.2.6	Vacuum pump failed 2E-98-41	12/22@16:45 - 12hrs 12/22@24:00	19:15	HPT 24
10	241-AP Primary Stack	RL-PHMC-TANKFARM-1998-0087	Personnel LCO 3.1.4A	242-A power outage took remote alarm out of service	N/A	N/A	N/A
11	241-AP-101 Annulus Leak	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
	Detection						
12	241-AP-102 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0045	Conduct of Ops	CAM out of tolerance per HPT who misread test meter - CAM was okay.	N/A	N/A	N/A
13	241-AP-103 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
14	241-AP-104 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0045	Conduct of Ops	CAM out of tolerance per HPT who misread test meter - CAM was okay.	N/A	N/A	N/A
15	241-AP-105 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0003	Equipment failure LCO 3.2.6	Vacuum pump failed 2E-98-177 Failure was discovered by craft - would otherwise been found by HPT during daily inspection	1/9@20:20 - 12hrs 1/9@24:00	15:40	Craft / HPT 24
	241-AP-105 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0033	Equipment failure LCO 3.2.6	CAM failed efficiency test 2E-98-693	3/29@11:05 - 360hrs 3/30@16:00	388:55	Source Check 720
	241-AP-105 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0045	Conduct of Ops	CAM out of tolerance per HPT who misread test meter - CAM was okay.	N/A	N/A	N/A
16	241-AP-106 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
17	241-AP-107 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
18	241-AP-108 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
19	241-AW Primary Stack	RL-PHMC-TANKFARM-1998-0068	Equipment failure LCO 3.1.4	High voltage transformer failed	6/23@10:04 - 3hrs 6/23@10:19	3:15	Ops 6
	241-AW Primary Stack	RL-PHMC-TANKFARM-1998-0092	Personnel LCO 3.2.1	Shutdown power supply at 271-AW	7/30@10:45 7/30@11:25	00:40	Craft 0
	241-AW Primary Stack	RL-PHMC-TANKFARM-1998-0093	External Phenomena LCO 3.1.4	CAMs failed due to heavy rains 2E-98-1605	7/31@10:50 - 3hrs 7/31@24:00	16:10	Ops 6
	241-AW Primary Stack	RL-PHMC-TANKFARM-1998-0137	Equipment failure LCO 3.1.4	CAM power supply cable failed	11:10@13:06 - 3hrs 11/10@13:21	3:15	Ops 6

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
	241-AW Primary Stack	RL-PHMC-TANKFARM-1998-0151	Equipment failure LCO 3.1.4	CAM failed source check 2E-98-2692	12/22@16:30 - 360hrs 12/23@10:30	378:00	Source Check 720
	241-AW Primary Stack	RL-PHMC-TANKFARM-1998-0153	Personnel LCO 3.1.4	Air sample hose had come loose	12/26@13:30 - 12hrs 12/26@14:30	13:00	HPT 24
20	241-AW-101 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0074	Equipment failure LCO 3.2.6	CAM failed source check 2E-98-1258	6/29@14:29 - 360hrs 6/30@11:02	380:33	Source Check 720
	241-AW-101 Annulus Leak Detection	RL-PHMC-TANKFARM-1997-0107	Equipment failure LCO 3.2.6	Vacuum pump failed 2E-98-47	12/30@14:45 - 12hrs 12/30@24:00	21:15	HPT 24
21	241-AW-102 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
22	241-AW-103 Annulus Leak Detection	RL-PHMC-TANKFARM-1997-0107	Equipment failure LCO 3.2.6	Vacuum pump failed 2E-98-47	12/30@14:45 - 12hrs 12/30@24:00	21:15	HPT 24
23	241-AW-104 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
24	241-AW-105 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0074	Equipment failure LCO 3.2.6	CAM failed source check 2E-98-1258	6/29@14:29 - 360hrs 6/30@11:02	380:33	Source Check 720
25	241-AW-106 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
26	241-AY-102 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
27	241-C-105/106 Primary Stack	RL-PHMC-TANKFARM-1998-0101	Equipment failure LCO 3.2.2	Vacuum pump breaker tripped - reason unknown - pump restarted okay	8/14@16:03 -3hrs 8/14@16:40	3:37	Ops 6
	241-C-105/106 Primary Stack	RL-PHMC-TANKFARM-1998-0093	External Phenomena LCO 3.2.2	CAMs failed due to heavy rains 2E-98-1606	7/31@10:50 -3hrs 7/31@24:00	16:10	Ops 6
	241-C-105/106 Primary Stack	RL-PHMC-TANKFARM-1998-0034	Procedure LCO 3.2.2	CAM shutdown exhauster during testing	3/29@11:28 3/29@11:45	00:17	Testing 0
	296-C-006 Primary Stack	RL-PHMC-TANKFARM-1998-0126 RL-PHMC-	Equipment failure	External flow indicator (FI-1366) exhibited 11 intermittent	10/11 thru 10/25 - 3hrs X	39:20	Ops 6

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
		TANKFARM-1998-0127	LCO 3.1.4	failures between 10/11 and 10/25. Flow indicator was replaced 10/25. 2E-98-2176	11		
28	241-SX Primary Stack	RL-PHMC-TANKFARM-1998-0094	Equipment failure LCO 3.1.4	Filter holder O-ring seal failed	7/30@12:30 - 168hrs 7/30@13:30	169:00	Filter Chg 336
	241-SX Primary Stack	RL-PHMC-TANKFARM-1999-0009	Equipment failure LCO 3.2.2	Vacuum pump failed 2W-99-199	2/8@00:10 - 3hrs 2/10@14:00	64:50	Ops 6
	241-SX Primary Stack	RL-PHMC-TANKFARM-1999-0068	Equipment failure LCO 3.1.4	Filter holder O-ring seal failed 2W-99-1349	9/21@12:30 - 168hrs 9/22@16:00	195:30	Filter Chg 336
	241-SX Primary Stack	RL-PHMC-TANKFARM-1998-0019	Equipment failure LCO 3.1.4	Vacuum hose came loose	3/4@13:37 - 3hrs 3/4@14:25	3:48	Ops 6
	241-SX Primary Stack	RL-PHMC-TANKFARM-1998-0036	Procedure LCO 3.2.2	Craft inadvertently changed setpoint	3/31@14:10 3/31@14:15	00:05	Craft 0
	241-SX Primary Stack	RL-PHMC-TANKFARM-1998-0080	External Phenomena LCO 3.1.4, 3.2.2	CAM failed due to rain coming through open cabinet doors 2W-98-1088	7/10@23:25 - 3hrs 7/11@19:12	22:47	Ops 6
29	241-SY Primary Stack	RL-PHMC-TANKFARM-1997-0095	Personnel LCO 3.2.1	Improper use of source check procedure	11/20@14:00 11/20@14:01	00:01	Testing 0
	241-SY Primary Stack	RL-PHMC-TANKFARM-1998-0110	Personnel LCO 3.1.4	Source check procedure noncompliance	N/A	N/A	N/A
	241-SY Primary Stack	RL-PHMC-TANKFARM-1999-0027	Equipment failure LCO 3.1.4	Vacuum pump failed, primary exhauster was shutdown and backup exhauster was started. Backup exhauster has its own CAM and fan interlock. 2W-99-745	5/1@9:47 - 12hrs 5/1@11:05	13:18	HPT 24
	241-SY Primary Stack	RL-PHMC-TANKFARM-1999-0031	Personnel LCO 3.1.4	Failure to communicate current equipment condition - CAM was out of service at switch from P-28 to K1 exhauster.	6/2@11:03 6/2@11:25	00:22	Testing 0
	241-SY Primary Stack	RL-PHMC-TANKFARM-1998-0094	Equipment failure LCO 3.1.4	Filter holder O-ring seal failed	7/30@12:30 - 168hrs 7/30@13:30	169:00	Filter Chg 336
	241-SY Primary Stack	RL-PHMC-TANKFARM-1998-0058	Equipment failure LCO 3.2.1	CAM failure 2W-98-941 Exhauster startup on 6/7 not noted on OR - end time shown, therefore, is 30	6/7@9:42 - 3hrs 6/7@16:00	7:18 . 12:22	Ops 6

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
				minutes before end of shift.E70	6/8@9:50 - 3hrs 6/8@19:28		
30	241-SY Backup Stack	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
31	241-SY-101 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
32	241-SY-102 Annulus Leak Detection	RL-PHMC-TANKFARM-1998-0133	External Phenomena LCO 3.2.6	Background Radon buildup - CAM performed as designed	N/A	N/A	N/A
33	241-SY-103 Annulus Leak Detection	No Occurrence Reports	N/A	N/A	N/A	N/A	N/A
34	242-T Primary Stack	RL-PHMC-TANKFARM-1998-0094	Equipment failure SAR-009	Filter holder O-ring seal failed	7/30@12:30 - 168hrs 7/30@13:30	169:00	Filter Chg 336
35	244-A DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0093	External Phenomena LCO 3.1.4	CAM's failed due to heavy rains 2E-98-2088	7/31@10:50 - 3hrs 7/31@24:00	16:10	Ops 6
	244-A DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0011	Personnel LCO 3.1.4A	Setpoint was inadvertently changed	2/3@18:25 - 12hrs 2/3@24:00	17:35	HPT 24
36	244-BX DCRT Primary Stack	RL-LMHC-TANKFARM-1999-0008	Equipment failure LCO 3.1.4	Vacuum pump failed 2W-99-1532, 1495 The exhauster was shutdown and is used during transfers only. Vacuum pump was not replaced.	10/19@10:10 - 12hrs 10/19@10:24	12:14	HPT 24
	244-BX DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0023	Equipment failure LCO 3.1.4	Vacuum pump breaker tripped - reason unknown - pump & exhauster restarted.	3/11@8:50 - 3hrs 3/11@11:18	5:28	Ops 6
	244-BX DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0055	Equipment failure LCO 3.1.4	Vacuum pump power supply failed due to excessive heat in CAM cabinet. First event: power supply reset - functioned properly. Second event: Exhauster was shutdown.	5/30@9:57 - 12hrs 5/30@10:04 5/31@7:30 - 12hrs 5/31@8:25	12:07 . 12:55	HPT 24
	244-BX DCRT Primary Stack	RL-PHMC-TANKFARM-1999-0032	Equipment failure LCO 3.1.4	Vacuum pump failed 2W-99-875 Exhauster was shutdown. Vacuum pump was replaced at a later date.	6/3@10:35 - 12hrs 6/3@10:39	12:04	HPT 24

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
37	244-CR Primary Stack	RL-LMHC-TANKFARM-1999-0005	Equipment failure LCO 3.1.4	Loss of CAM vacuum flow 2E-99-2106, 2211	10/10@00:47 10/11@15:35	38:48	Cont Rm Ops 0
	244-CR Primary Stack	RL-PHMC-TANKFARM-1998-0095	Equipment failure LCO 3.1.4A	CAM failure 2E-98-1624	8/3@11:00 - 3hrs 8/9@16:00	152:00	Ops 6
	244-CR Primary Stack	RL-PHMC-TANKFARM-1998-0114	Equipment failure LCO 3.1.4A	C-Substation failure (power supply for 244-CR)	9/14@13:38 - 3hrs 9/14@19:10	8:32	Ops 6
38	244-S DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0052	Equipment failure LCO 3.1.4	CAM failed At 5/14@2:40 the exhauster was shutdown pending CAM replacement.	5/14@1:19 - 3hrs 5/14@2:40	4:21	Ops 6
39	244-TX DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0110	Personnel LCO 3.1.4	Source check procedure noncompliance	N/A	N/A	N/A
	244-TX DCRT Primary Stack	RL-PHMC-TANKFARM-1999-0053	Equipment failure LCO 3.1.4	Vacuum pump failed 2W-99-1095	7/30@15:45 - 12hrs 7/31@13:30	33:45	HPT 24
	244-TX DCRT Primary Stack	RL-PHMC-TANKFARM-1998-0007	Equipment failure LCO 3.1.4	Vacuum pump failed 2W-98-102 The exhauster was shutdown - exact time unknown - assumed by shift end. The vacuum pump was replaced at a later date.	1/17@6:00 - 12hrs 1/17@8:00	14:00	HPT 24
40	702-AZ Primary Stack	RL-PHMC-TANKFARM-1999-0044	Equipment failure LCO 3.1.4	CM-1 failure in cabinet 2E-98-2307	7/16@2:29 7/16@2:34	00:05	Cont Rm Ops 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0125	Equipment failure LCO 3.1.4	CM-1 failure in cabinet 2E-98-2307	10/10@9:25 - 3hrs 10/10@9:50	3:25	Ops 6
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0108	Defective material LCO 3.1.4A	Faulty replacement light bulb cascaded into power failure to vacuum pump. Vacuum pump startup was not noted on OR - end time shown, therefore, is 30 minutes before end of shift.	8/28@11:25 8/28@16:00	4:35	Craft 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0109	Equipment failure LCO 3.1.4A	CAM failed due to chiller failure	8/30@11:10 8/30@11:45	00:35	Cont Rm Ops 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0154	Testing anomaly LCO 3.1.4	CAM sent High Rad signal during re-energizing after testing	12/28@9:55 12/28@10:05	00:10	Testing 0

Table A-1. Summary: Hours of Service and Frequency of Continuous Air Monitor Failures. (7 Sheets)

	Location	Occurrence Report	Failure Mode	Out of Service Notes	Time Unavailable	Hours Unavailable	Discovery Period
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1999-0026	Equipment failure LCO 3.1.4	CM-1 failure in cabinet. 2E-98-2307 Several instances of loss of vacuum flow of approx. 2 minutes each.	Specific dates/times unknown.	00:20	Cont Rm Ops 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1999-0054	Equipment failure LCO 3.1.4	Flow control valve failed Start 7/31@19:40 End 7/31@19:44	7/31@19:40 7/31@19:44	00:04	Cont Rm Ops 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1999-0046	Equipment failure LCO 3.1.4	Loose connection in vac pump circuit	7/20@13:27 7/20@13:46	00:19	Craft 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0028 RL-PHMC-TANKFARM-1998-0029	Personnel LCO 3.1.4A	CAM failure due to seal pot overflow 2E-98-677, 683, 703, 1287 CAM returned to service 3/25 - exact time unknown - assumed by shift end.	3/21@12:10 - 3hrs 3/25@16:00	102:50	Ops 6
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0062	Equipment failure LCO 3.1.4A	CM-1 failure in cabinet 2E-98-1286	6/12@10:10 6/12@16:00	5:50	Cont Rm Ops 0
	702-AZ Primary Stack	RL-PHMC-TANKFARM-1998-0081	Equipment design LCO 3.1.4A	Backdraft damper oscillation caused low flow through CAM	7/10@14:42 7/10@14:52	00:10	Craft 0
	General	RL-PHMC-TANKFARM-1999-0047	System	Engineering evaluation to assess operability of CAM interlock system	N/A	N/A	N/A

APPENDIX B

CONTINUOUS AIR MONITOR AVAILABILITY ANALYSIS

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	A	B	C
1	**CAM - Availability Analysis**		
2	**Formulas II - Observed Availability**		
3			
4			
5			
6	**Operations Data**		
7	**CAM Hours**	**=40*24*365*2**	
8	Simple Failures	70	
9	Source Check Failures	9	
10	Functional Test Failures	0	
11	**Failures (total)**	**=SUM(B8:B10)**	
12			
13	Time to Repair (simple check)	782	
14	Time to Repair (source check)	2656	
15	*Time to Repair (Functional Test)*	0	
16	**Total Time to Repair**	**=SUM(B13:B15)**	
17	MTBF (simple check)	=B7/B8	
18	MTBF (source check)	=B7/B9	
19	MTBF (functional test)	n/a	
20	**MTBF (total)**	**=B7/B11**	
21			
22	MTTR (simple check)	=B13/B8	
23	MTTR (source check)	=B14/B9	
24	**MTTR (total)**	=B16/B11	
25			
26	**Failure Frequencies**		
27	lambda simple	=B8/(B7)	
28	lambda source check	=B9/(B7)	
29	*lambda functional test*	=B10/(B7)	
30	**lambda (total)**	**=B11/B7**	
31			
32	**A(total) CAM**	**=(B7-B16)/B7**	
33			
34			
35			

	A	B	C
1	**Spreadsheet Formulas**		
2	**Calculated Availability**		
3			
4			
5			
6	**Operations Data**		
7	CAM Hours	=2*40*365*24	
8	Simple Failures	70	
9	Source Check Failures	9	
10	Functional Test Failures	1	
11	Time to Repair (simple check)	782	
12	Time to Repair (source check)	2656	
13	Time to Repair (Functional Test)	0	
14	MTBF (simple check)	=B7/B8	
15	MTBF (source check)	=B7/B9	
16	MTBF (functional test)	=B7/B10	
17	MTTR (simple check)	=B11/B8	
18	MTTR (source check)	=B12/B9	
19			
20	**Failure Frequencies**		
21	lambda simple	=B8/(B7)	
22	lambda source check	=B9/(B7)	
23	lambda functional test	=B10/(B7)	
24			
25	**Surveillance Frequencies (hours)**		
26	t simple	**24**	
27	t source check	**720**	
28	t functional test	**2208**	
29			
30	**Availability Based on Surveillance**		
31	A(sur) simple	=1-0.5*(B21*B26)	
32	A(sur) functional	=1-0.5*(B22*B27)	
33	A(sur) interlock	=1-0.5*(B23*B28)	
34	A(sur) CAM	=B31*B32*B33	
35			
36	**Availability Based on Time to Repair**		
37	A(repair) alarm	=(B14/(B14+B17))	
38	**A(total) CAM**	**=B37*B33*B32**	
39			
40			
41			

APPENDIX C

AVAILABILITY ANALYSIS CASES FOR RPP CONTINUOUS AIR MONITOR INTERLOCK SYSTEMS

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CAM - Availability Analysis

Availability based on observation = (Total CAM hours - Total Time to Repair)/(Total CAM hours)

<u>**Operations Data**</u>		
CAM Hours	**7.008E+05**	
Simple Failures	7.00E+01	
Source Check Failures	9.00E+00	
Functional Test Failures	0.00E+00	(there have been no observed functional test failures)
Failures (total)	**7.90E+01**	
Time to Repair (simple check)	7.82E+02	
Time to Repair (source check)	2.66E+03	
Time to Repair (Functional Test)	0.00E+00	
Total Time to Repair	**3.44E+03**	
MTBF (simple check)	1.001E+04	
MTBF (source check)	7.787E+04	
MTBF (functional test)	n/a	
MTBF (total)	**8.871E+03**	
MTTR (simple check)	1.117E+01	
MTTR (source check)	2.951E+02	
<u>**Failure Frequencies**</u>		
lambda simple	9.99E-05	
lambda source check	1.28E-05	
lambda functional test	0.00E+00	
lambda (total)	**1.13E-04**	
A(total) CAM	**0.995**	**(availability based on fraction of time observed available)**

CAM - Availability Analysis

(1. Failures detected by simple check, 2. Failures detected by source check, 3. Failure detected by system function check only)

Case 1 - CAM Availability - Based on Daily Simple Check, 30-Day Source Check, and a 92-Day Functional Test

Operations Data		
CAM Hours	7.008E+05	
Simple Failures	7.00E+01	
Source Check Failures	9.00E+00	
Functional Test Failures	1.00E+00	(one is conservative relative to experience of zero)
Time to Repair (simple check)	7.82E+02	
Time to Repair (source check)	2.66E+03	
Time to Repair (Functional Test)	0.00E+00	
MTBF (simple check)	1.001E+04	
MTBF (source check)	7.787E+04	
MTBF (functional test)	7.008E+05	
MTTR (simple check)	1.117E+01	
MTTR (source check)	2.951E+02	

Failure Frequencies	
lambda simple	9.99E-05
lambda source check	1.28E-05
lambda functional test	1.43E-06

Surveillance Frequencies (hours)		
t simple	**24**	(simple surveillance check frequency in hours)
t source check	**720**	(CAM source check frequency in hours)
t functional test	**2208**	(system functional test surveillance frequency in hours)

Availability Based on Surveillance		
A(sur) simple	9.988E-01	
A(sur) functional	9.954E-01	
A(sur) interlock	9.984E-01	
A(sur) CAM	**0.993**	**(availability if determined by surveillance frequency)**

CAM - Availability Analysis

(Failures detected by simple check, source check, and system function check are alarmed)

Case 2 - CAM Availability - If All CAM Failures Were Alarmed to a Continuously Manned Station with Immediate Response

Operations Data		
CAM Hours	7.008E+05	
Simple Failures	7.00E+01	
Source Check Failures	9.00E+00	
Functional Test Failures	1.00E+00	(one is conservative relative to experience of zero)
Time to Repair (simple check)	7.82E+02	
Time to Repair (source check)	2.66E+03	
Time to Repair (Functional Test)	0.00E+00	
MTBF (simple check)	1.001E+04	
MTBF (source check)	7.787E+04	
MTBF (functional test)	7.008E+05	
MTTR (simple check)	1.117E+01	
MTTR (source check)	2.951E+02	
Failure Frequencies		
lambda simple	9.99E-05	
lambda source check	1.28E-05	
lambda functional test	1.43E-06	
Surveillance Frequencies (hours)		
t simple	**0.5**	(failure alarm with 30-min response)
t source check	**0.5**	(failure alarm with 30-min response)
t functional test	**0.5**	(failure alarm with 30-min response)
Availability Based on Time to Repair		
A(repair) alarm	9.989E-01	
A(sur) functional	9.962E-01	
A(sur) interlock	1.000E+00	
A(total) CAM	**0.995**	**(availability determined by repair time)**

CAM - Availability Analysis

(1. Failures detected by simple check, 2. Failures detected by source check, 3. Failure detected by system function check only)

Case 3 - CAM Availability - Based on 92 Day Functional Test Only

Operations Data		
CAM Hours	7.008E+05	
Simple Failures	7.00E+01	
Source Check Failures	9.00E+00	
Functional Test Failures	1.00E+00	(one is conservative relative to experience of zero)
Time to Repair (simple check)	7.82E+02	
Time to Repair (source check)	2.66E+03	
Time to Repair (Functional Test)	0.00E+00	
MTBF (simple check)	1.001E+04	
MTBF (source check)	7.787E+04	
MTBF (functional test)	7.008E+05	
MTTR (simple check)	1.117E+01	
MTTR (source check)	2.951E+02	
Failure Frequencies		
lambda simple	9.99E-05	
lambda source check	1.28E-05	
lambda functional test	1.43E-06	
Surveillance Frequencies (hours)		
t simple	**2208**	(simple surveillance check frequency in hours)
t source check	**2208**	(CAM source check frequency in hours)
t functional test	**2208**	(system functional test surveillance frequency in hours)
Availability Based on Surveillance		
A(sur) simple	8.897E-01	
A(sur) functional	9.858E-01	
A(sur) interlock	9.984E-01	
A(sur) CAM	**0.876**	**(availability determined by surveillance frequency)**

CAM - Availability Analysis

(1. Failures detected by simple check, 2. Failures detected by source check, 3. Failure detected by system function check only)

Case 4 - CAM Availability – Specified Surveillance Times (LCO 3.1.4)

Operations Data		
CAM Hours	7.008E+05	
Simple Failures	7.00E+01	
Source Check Failures	9.00E+00	
Functional Test Failures	1.00E+00	(one is conservative relative to experience of zero)
Time to Repair (simple check)	7.82E+02	
Time to Repair (source check)	2.66E+03	
Time to Repair (Functional Test)	0.00E+00	
MTBF (simple check)	1.001E+04	
MTBF (source check)	7.787E+04	
MTBF (functional test)	7.008E+05	
MTTR (simple check)	1.117E+01	
MTTR (source check)	2.951E+02	
Failure Frequencies		
lambda simple	9.99E-05	
lambda source check	1.28E-05	
lambda functional test	1.43E-06	
Surveillance Frequencies (hours)		
t simple	**48**	(simple surveillance check frequency in hours)
t source check	**744**	(CAM source check frequency in hours)
t functional test	**2208**	(system functional test surveillance frequency in hours)
Availability Based on Surveillance		
A(sur) simple	9.976E-01	
A(sur) functional	9.952E-01	
A(sur) interlock	9.984E-01	
A(sur) CAM	**0.991**	**(availability determined by surveillance frequency)**

CAM - Availability Analysis

(1. Failures detected by simple check, 2. Failures detected by source check, 3. Failure detected by system function check only)

Case 5 - CAM Availability - Specified Surveillance Times Plus 25% (LCO 3.1.4)

Operations Data		
CAM Hours	7.008E+05	
Simple Failures	7.00E+01	
Source Check Failures	9.00E+00	
Functional Test Failures	1.00E+00	(one is conservative relative to experience of zero)
Time to Repair (simple check)	7.82E+02	
Time to Repair (source check)	2.66E+03	
Time to Repair (Functional Test)	0.00E+00	
MTBF (simple check)	1.001E+04	
MTBF (source check)	7.787E+04	
MTBF (functional test)	7.008E+05	
MTTR (simple check)	1.117E+01	
MTTR (source check)	2.951E+02	
Failure Frequencies		
lambda simple	9.99E-05	
lambda source check	1.28E-05	
lambda functional test	1.43E-06	
Surveillance Frequencies (hours)		
t simple	60	(simple surveillance check frequency in hours)
t source check	912	(CAM source check frequency in hours)
t functional test	2208	(system functional test surveillance frequency in hours)
Availability Based on Surveillance		
A(sur) simple	9.970E-01	
A(sur) functional	9.941E-01	
A(sur) interlock	9.984E-01	
A(sur) CAM	**0.990**	**(availability determined by surveillance frequency)**

APPENDIX D

COPY OF CONTRACTOR SURVEILLANCE REPORT RESPONSE S99-TOD-TF-042-FO1

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RL-F-5482.2
(10/97)

Surveillance Number: S99-TOD-TF-042-F01

Date: September 2, 1999

CONTRACTOR SURVEILLANCE REPORT RESPONSE

DOE-RL Author: B. J. Harp

Subject/Scope of Surveillance:
Technical Safety Requirements

Surveillance Results:

Safety class system operability requirements were not met for the ventilation stack continuous air monitor (CAM) interlock system (LCO 3.1.4).

Requirement: DOE Order 5480.22, "Technical Safety Requirements," Attachment 1, Section II, Paragraphs 2.4(h) and 2.5 are implemented through HNF-DS-WM-TSR-006, "Tank Waste Remediation System Technical Safety Requirements."

Backgroud: Provided on page 2

Discussion and Explanation:

DOE Discussion and Explanation: The definition of operable-operability (HNF-SD-WM-TSR-006) specifies that a system and all necessary attendant equipment shall be capable of performing the systems specified function. The functional requirement for the CAM (HNF-SD-WM-SEL-040) specifies that the CAM must measure the sample flow stream and shutdown the exhauster within 10 minutes of exceeding a preset radiation level. Continued on page 2

Root Cause:

4B - Design Problem; inadequate or defective design

Corrective Actions:

1. Perform an engineering evaluation to provide reasonable assurance of operability with applicable compensatory actions (if needed) - Plant Engineering by 09/08/99.
2. Perform an engineering evaluation to determine failure modes that affect the intended safety function of the CAMs with regard to the interlock TSR and make necessary recommendations to correct any deficiencies - Equipment Engineering by 11/15/99.
3. Analyze surveillance frequency to determine adequacy - Safety Analysis by 11/15/99.
4. After completion of the engineer evaluation, develop a corrective action plan for implementation - Tank Farm Facility Operations by 12/27/99.

Planned Completion Date: December 27, 1999

Responsible Contractor Individual: C. DiFrango [signature] for C.D.

RL-F-5482.2
(10/97)

Surveillance Number: S99-TOD-TF-042-F01

Date: September 2, 1999

CONTRACTOR SURVEILLANCE REPORT RESPONSE (CONTINUATION)

SURVEILLANCE RESULTS: - continued

Background: The computer automated surveillance system (CASS) provided remote alarms, at a continuously manned location, that detected equipment failures of the CAM interlock system. The CASS was removed from service based on the results of unreviewed safety question determinations (USQDs) TF-98-0829 and TF-99-0142. These USQDs provided the justification for eliminating CASS.

The TSR bases section for LCO 3.1.4 references the calculation note that analyzed a HEPA filter failure accident and subsequent radionuclide release with a 10 minute duration. The consequence of the 10 minute release was within acceptance guidelines. Based on this analyses, a 10 minute ventilation system shutdown time for the stack CAM interlock system was established.

DISCUSSION AND EXPLANATION: - continued

DOE Discussion and Explanation: - continued
Contrary to this functional requirement, the CAM is not capable of shutting down the exhauster within 10 minutes when a CAM equipment failure, e.g. vacuum pump, occurs. If an equipment failure occurred, the CAM could operate for up to 6 hours in an inoperable status because the CAM is not interlocked to shutdown the exhauster and alarms are not monitored continuously. Therefore, the ventilation stack CAM interlock system does not meet operability requirements because the system 10 minute shutdown functional requirement cannot be met upon failure of a system safety class component.

LMHC Discussion and Explanation: HNF-SD-WM-SEL-040, Section 6.1.1.3 states the "The CAM shall activate an interlock to shut down the exhauster within 10 minutes of detecting a radiation level that exceeds the preset level. On CAM failure, the monitors must actuate an alarm and/or an interlock to shut down the exhaust system." These two sentences differentiate between CAM activation due to detecting radiation levels and CAM failures. The interlock and 10 minute requirements are applicable to CAM activation. CAM system failure is detected by remote monitors located in instrument buildings. This is considered acceptable because of the low probability of an event occurring concurrent with a supporting system failure.

APPENDIX E

CHECKLIST FOR TECHNICAL PEER REVIEW

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Practice 134 290 1112
Publication Date 22Nov99
Attachment 02 - Sheet 1 of 1

FLUOR DANIEL NORTHWEST

TECHNICAL PEER REVIEWS

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: RPP-5453
Title: AVAILABILITY ANALYSIS OF THE VENTILATION STACK CAM INTERLOCK SYSTEM
Author: JON YOUNG
Date: 7/31/00
Scope of Review: CHANGES DOCUMENTED VIA ECN 661800

Yes	No*	NA	
[X]	[ ]	[ ]**	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[ ]	[ ]	[X]	Problem completely defined.
[ ]	[ ]	[X]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity, or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[ ]	[ ]	[X]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[ ]	[ ]	[X]	Conclusions consistent with analytical results and applicable limits.
[ ]	[ ]	[X]	Results and conclusions address all points required in the problem statement.
[X]	[ ]	[ ]	Format consistent with applicable guides or other standards.
[ ]		[X]**	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	Document approved (for example, the reviewer affirms the technical accuracy of the document).

GRANT W. RYAN [signature] — Reviewer (printed name and signature)

7/31/00 — Date

* All "no" responses must be explained below or on an additional sheet.

** Any calculations, comments, or notes generated as part of this review should be signed, dated, and attached to this checklist. The material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

NUCLEAR ENGINEERING

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